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Treatment of Painful Nonunion of the Distal Phalanx in the Finger With Bone Graft and Dorsal Reverse Adipofascial Flap Based on an Exteriorized Pedicle

Nadja A. Müller, MD, Maurizio Calcagni, MD, and Thomas Giesen, MD

Abstract: Reconstruction of the distal phalanx bone in cases with painful nonunion is a rare and challenging problem. To restore anatomy and to provide a good cover for the bone graft, an intact nailbed is often required due to the proximity of these 2 structures. We present 3 cases of distal phalanx reconstruction performed with a free corticocancellous bone graft from the distal radius and nailbed reconstruction with a homodigital dorsal reverse adipofascial flap based on an exteriorized pedicle that avoids the dissection of the germinal matrix of the nail. All bone grafts consolidated and all flaps survived. All nail plates grew back with no deformity. In this rare but challenging problem, our combined technique appears to be a valid option that enhances the possibility of good bone healing and maximizes the cosmetic result.

Key Words: distal phalanx, nonunion, bone graft, nailbed reconstruction, dorsal reverse flap

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Painful nonunion of the distal phalanx in the middle part is a rare and challenging problem.[1] When it occurs, it causes pain and instability of the fingertip and prohibits proper use of the hand in basic manual tasks, such as pinching or grasping objects.[2] Accompanying nailbed deformity can cause additional pain and disturbance and is also an esthetic issue. Whereas asymptomatic nonunion of the distal phalanx tuft does not require intervention, symptomatic tuft nonunion can be treated by simple removal of the bone fragment.[2,3] The reconstruction of the distal phalanx bone in cases with a painful nonunion of P3 shaft combined with nailbed deformity requires more complex surgery than simple fragment removal to restore anatomy and function. The critical point is the need to provide an optimal vascularized cover for the bone graft to promote bone healing, and at the same time to reconstruct a nailbed that is often disrupted and/or scarred.

The germinal matrix of the nail should be preserved.

We present our experience with 3 cases of distal phalanx reconstruction performed with a free corticocancellous bone graft from the radius combined with nailbed reconstruction with a dorsal reverse adipofascial flap based on an exteriorized pedicle, which avoids dissection of the germinal matrix/eponychium.

From the Department of Plastic Surgery and Hand Surgery, University Hospital Zurich, Zurich, Switzerland.

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Address correspondence and reprint requests to Nadja A. Mueller, MD, Department of Plastic Surgery and Hand Surgery, University Hospital Zurich, Rämistrasse 100, Zurich CH-8091, Switzerland.
E-mail: n.a.mueller@me.com.

ANATOMY

For relevant anatomy, see Figures 1 and 2A, B with a diagram of the injured bone-nailbed complex, a related x-ray of a clinical case, and a clinical picture. See Figure 5 for a schematic diagram of the flap and the procedure.

This flap is based on the distal dorsal branches of the digital arteries that originates just distal to the distal interphalangeal joint on either side, forming a rich vascular bed on top of the extensor tendon insertion just proximal to the germinal matrix.[4,5]

SURGICAL TECHNIQUE

All operations were performed under regional anesthesia with a tourniquet, using loupe magnification.

The nailbed was opened with a transverse incision to expose the bone. We then resected the fibrotic tissue at the nonunion site until vital bone was seen. At this point, we measured the bone defect and harvested an adequate corticocancellous bone graft from the radial styloid of the same arm.

Under image intensifier the graft was fitted into the bone defect and stabilized with 2 longitudinal 0.8 mm Kirschner wires in a retrograde manner with temporary osteodesis of distal interphalangeal joint (DIP) joint (Fig. 3).

We then ascertained that the nailbed was of an insufficient thickness in 2 cases; in the third case there was damage due to manipulation of bone fragments.

At this point, using a lazy S incision on the dorsum of the P2, we raised an adipofascial flap as described by Laoulakos et al[5] in 2003 based on the dorsal arterial vessels distal to the DIP joint (Figs. 4A, B, 5).

We observed some difficulty in raising the adipofascial flap around the proximal interphalangeal joint (PIP) joint as the tissue to be included in the dissection was very thin and prone to damage.

We took care not to incise the proximal dorsal skin of the distal phalanx to maintain optimal vascularization of the flap and to leave the germinal matrix of the nail inviolate. We

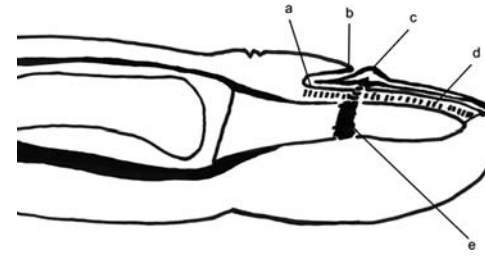

FIGURE 1. Diagram of the nonunion of the bone and consequent nailbed complex disruption: (a) nail matrix, (b) eponychium, (c) damaged nailbed and nail plate, (d) nailbed, and (e) nonunion.

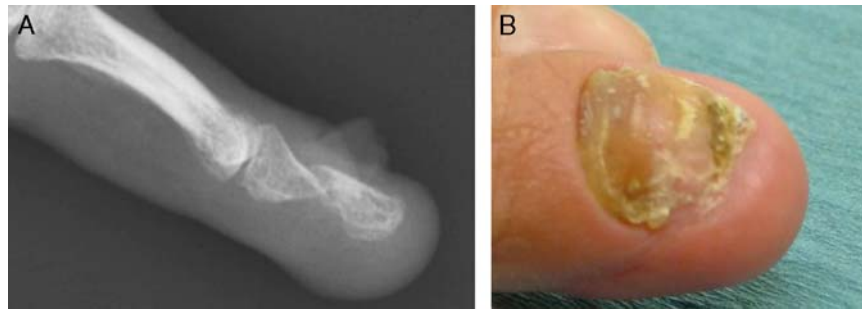

FIGURE 2. X-ray of a clinical case of a painful nonunion of the distal phalanx (A) and clinical picture with nail deformity (B). full color online

turned the flap over and covered the exposed bone, fixing the flap with 5.0 dissolvable suture to the distal remnants of the previously resected nailbed.

The donor site was closed to the point that the sutures were not strangulating the pedicle distally and the flap was left to reepithelize.

The epithelium of the nailbed regenerated from the distal remnants of the resected nailbed over the fat tissue of the flap.

In 2 cases the reepithelialization was not complete at the time of separation of the pedicle and inset of the flap. We eventually achieved a complete reepithelialization of the new nailbed using daily moist dressing and before nail plate regrowth (Fig. 6A).

The patients were immobilized postoperatively with PIP and DIP in extension for 2 weeks, till separation of the pedicle, and instructed on how to keep the flap and the pedicle moist with the application of saline solution on the flap 3 times a day.

In all cases the exteriorized pedicle was divided under local anesthesia after 2 weeks and a definitive inset of the new nailbed was performed in the same procedure (Fig. 6B).

The pedicle was first divided proximally where emerging form the dorsal skin of the finger. Then we resected the proximal excess of flap to match the length of the proximal remnant of germinal matrix, and then we adapted the flap with it with 6.0 dissolvable sutures.

Gentle active and passive mobilization of the PIP joint was started after division of the pedicle.

The K wires were removed 8 weeks postoperatively, following radiologic consolidation of the bone.

Follow-up

All patients were followed up for 6 months. We recorded any acute or late complication.

We recorded at every follow-up the function of the finger, residual pain, and the satisfaction of the patient.

RESULTS

From April 2012 to November 2014, 3 patients presented with a painful nonunion of the distal phalanx of a finger following a previous crush injury to the distal phalanx. All of them had an

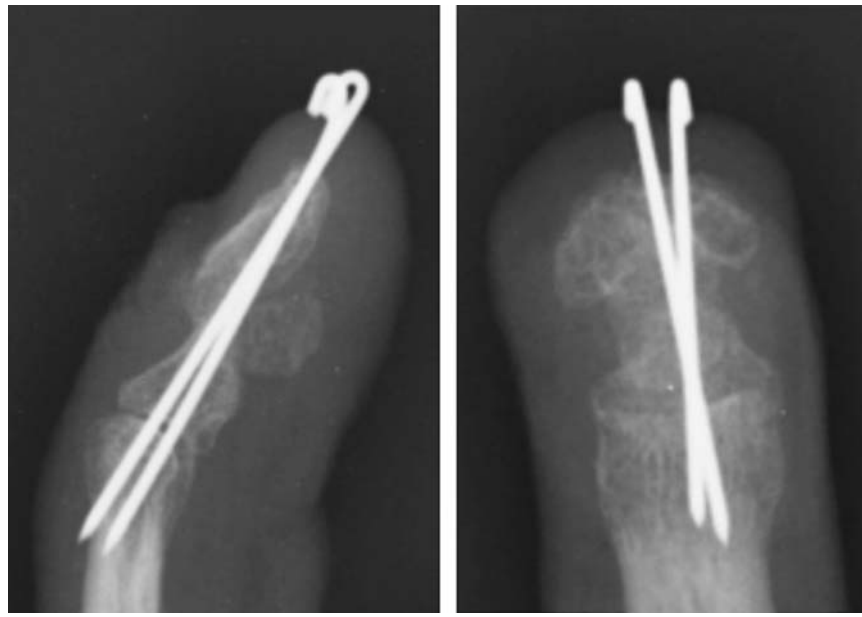

FIGURE 3. Bone graft and fixation with K wires through the DIP Joint. This x-ray is showing the consolidation of the nonunion at 6 weeks after the first operation.

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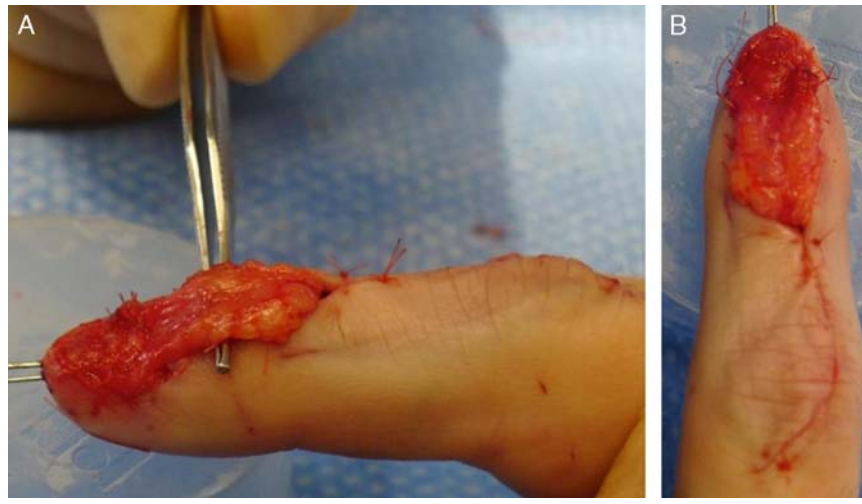

FIGURE 4. Intraoperative picture under tourniquet: the adipofascial flap harvested from the dorsal side of the finger is turned over to cover the bone graft and reconstruct the nailbed. The flap is left outside the intact skin of the eponychium (A, B). full color online

associated severe nailbed deformity. Criteria for nonunion were defined clinically by pain and instability at the fracture site at least 6 months after the injury, and radiologically by a visible fracture gap and sclerosis of the fragments. The time between the previous trauma and being seen in the clinic was at least 6 months (6, 7, and 9 mo, respectively). All patients were men, aged 41, 53, and 63 years. The finger involved was the ring finger in 2 cases and the index finger in 1 case.

No loss of flap was observed and all bone grafts healed within 8 weeks. No infection was recorded. All nail plates grew back with no or minimal deformity. All patients were satisfied with the reconstruction and had no residual pain after 6 months. All of them went back to their previous work (Figs. 7A–C).

All patients showed an acceptable active range of motion of a mean value of 30 degrees at the DIP joint. The proximal interphalangeal joints recovered full motion in all cases.

COMPLICATIONS

One patient required a resection of redundant bone graft from the pulp of his middle finger after 14 weeks.

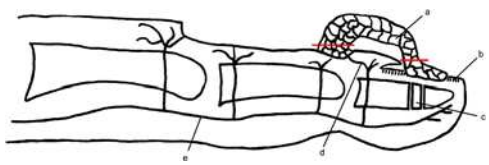

FIGURE 5. Diagram of the reversed adipofascial flap for reconstruction of the nailbed and resected nonunion with bone graft in the distal phalanx: (a) dorsal reverse adipofascial flap based on exteriorized pedicle, (b) nailbed, (c) corticocancellous bone graft, (d) distal dorsal branch of the digital artery feeding the flap (originating distal to the distal interphalangeal joint), (e) digital artery red lines: flap division lines after 2 weeks for definitive inset. full color online

DISCUSSION

Distal phalangeal fractures are among the most common fractures in the hand.[1] Although most can be treated conservatively, symptomatic nonunion of distal phalangeal fractures occurs occasionally.[1] Associated nailbed destruction deformity is more rare and associated normally with crush injuries. The treatment of the combination of these 2 problems might pose a challenge to the surgeon.

Infections, injury to the surrounding soft tissue, and open fractures with or without segmental bone loss are the main risk factors in developing nonunion of the distal phalanx of the fingers of the hand.[3,6]

We also find in the literature that soft-tissue damage and impaired circulation following trauma affects the distal phalanx bone fragments' healing potential and increases the incidence of infection and nonunion.[2,7]

The key points in distal phalanx reconstruction are a correct reposition and sufficient soft-tissue coverage to provide the best possible blood supply. The integrity of the nailbed is an important factor because of its direct adherence to the bone and also due to its importance for the formation of an intact, smooth, and compact nail.[8]

In the literature, only a few reports can be found about treatment for nonunion of the distal phalanx.[2,9–13] Chim et al[11] treated 14 cases of distal phalanx nonunion by performing open reduction and interfragmentary screw fixation using a dorsal approach through the nailbed and reported good functional results without using a bone graft, accepting some shortening of length in distal phalanx.

To the best of our knowledge, there is no description in the literature about the treatment of the combination of post-traumatic nailbed deformity and painful nonunion of the distal phalanx of the digit.

Laoulakos et al[5] in 2003 described the technique of dorsal reverse adipofascial flap as a 1-step operation, covering the flap with split-thickness skin graft.

In 2007, this technique, in combination with an exteriorized pedicle technique, was described by Rampazzo et al[14] for reconstruction of a fingertip amputations. Rampazzo et al[14] described that coverage of the exteriorized pedicle flap with skin graft is not needed because of rapid, spontaneous

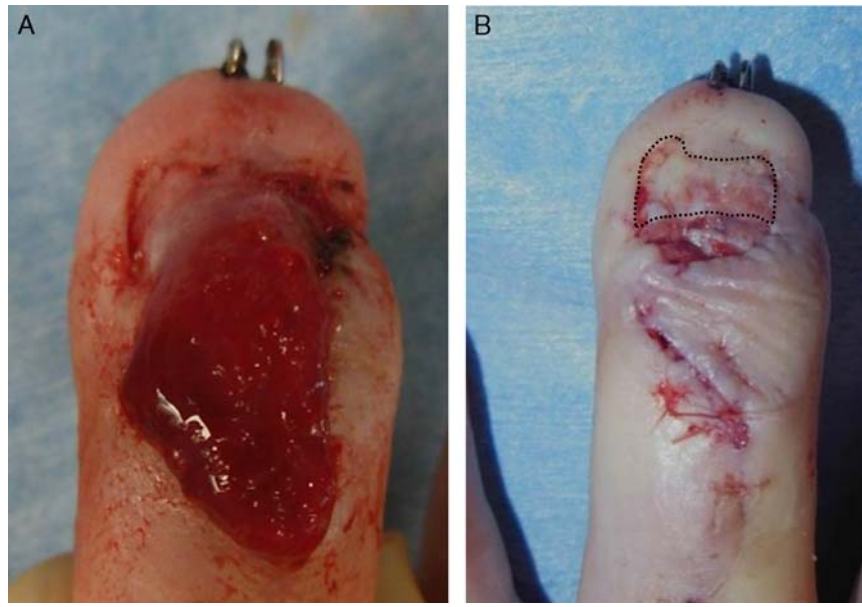

FIGURE 6. The flap after 2 weeks: the epithelium of the remnant of the nailbed has regrown over the flap (A). The pedicle of the flap is then excised and the flap thinned and adapted to the proximal margin of the nailbed for a definitive in-setting. The dotted line outlines the margins of the flap (B). full color online

reepithelialization and they also described that it is not necessary to cut the skin over the distal phalanx and eponychium to ease the passage of the flap.

In our presented technique, we combined the resection of the painful nonunion and bone reconstruction with bone graft harvested from the distal radius with the use of the dorsal reverse adipofascial flap for reconstruction of the nailbed with an exteriorized pedicle, as in the case report presented by Rampazzo et al.[14]

This combined technique has several advantages:

The bone graft is covered by well-vascularized soft tissue to promote bone healing. In our small series, the quality of the soft-tissue cover for the graft is allegedly of a better quality than a scarred nailbed. Our cases consolidated without screw fixation. This fact might suggest that having a fresh vascularized soft-tissue cover is a condition sufficient alone to promote bone healing, without the need for a compressive fixation as achieved by using screws. Therefore, the use of screws, that might be difficult with regards to the dimension of the bone fragments, can be avoided with our combination of techniques.

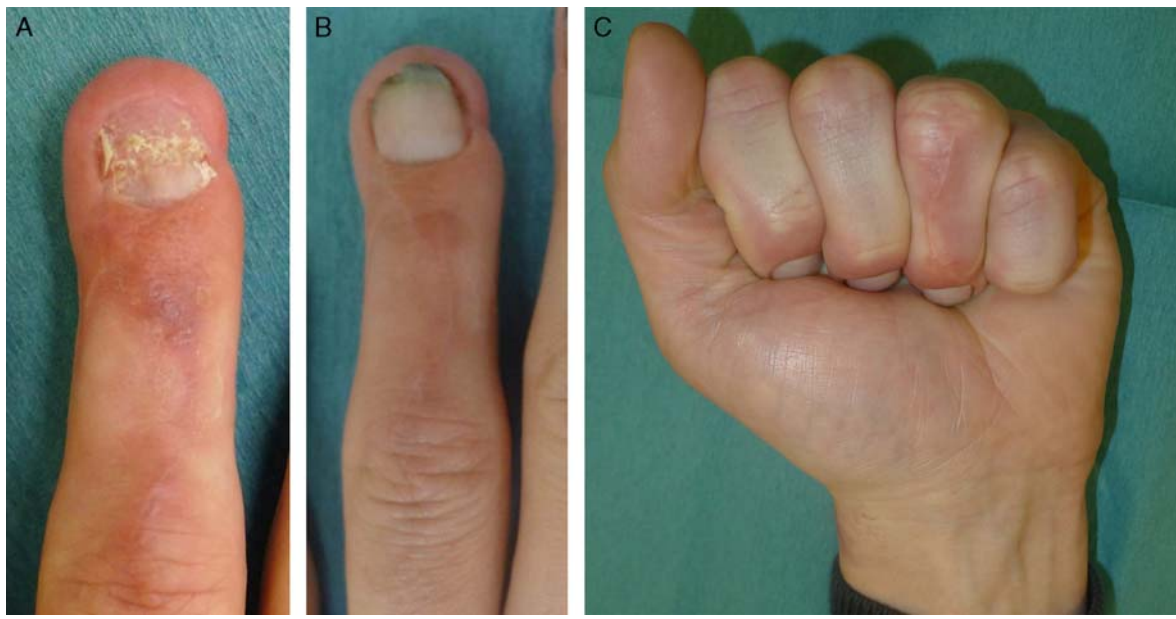

FIGURE 7. Nail regrowth after 8 weeks (A) and after 6 months (B) with a negligible esthetic defect. The range of motion of the operated finger after 6 months (C). full color online

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The reconstruction of the nailbed leaving the germinal matrix undisturbed has shown good esthetic results in our series with all patients being satisfied with the outcome.

Furthermore, skin graft donor-site morbidity is avoided.[14]

Nail deformity reconstruction is achieved in acute traumatic and oncologic cases with simple dermal or dermoepidermal grafts. In more complex reconstructions, involving soft tissue and bone reconstruction, the priority is not only the restoration of the former but also the healing of the latter. Simple grafts would not provide an ideal environment to promote bone healing and would probably also fail because of the avascularity of the underlying free bone graft.

Unfortunately as this sequence of crush injuries is rare, it is difficult to gather a large series of patients.

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